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Report No. SPB-67 November 19, 1996

Report of the Satellite Digital Audio Radio Service
Pioneer's Preference Review Panel: Request for Comments

By letter dated August 30, 1996, the Office of Engineering and Technology and the International Bureau requested that a specially convened panel of four satellite technology experts review three pending requests for pioneer's preferences for satellite digital audio radio service (satellite DARS) licenses and recommend to the Commission whether or not one or more of the requests should be granted. The Panel's written evaluation of the requests and its recommendations with respect to each are contained in the attached report, dated November 18, 1996, entitled "Evaluation of Pioneer's Preference Applications to the FCC that were submitted by Three DARS Applicants." A list of documents forwarded to the Panel for review is also attached.

The experts on the Panel are: Dr. H. Donald Messer, Broadcast Satellite Program Manager at the U.S. Information Agency's Voice of America; John T. Gilsenan, Deputy Director for Radio Spectrum Policy at the U.S. Department of State; James E. Hollansworth, Telecommunications Specialist at the National Aeronautics and Space Administration (NASA); and William G. Long, Jr., a satellite expert with the Defense Information Systems Agency (DISA).

We request public comment on the Panel's report and recommendations. Comments filed in response to this public notice should reference this public notice, Report No. SPB-67, and be filed on or before **December 3, 1996.** Copies of relevant documents will be available for public inspection in the International Reference Center, 2000 M Street, N.W., Room 102, Washington, D.C., and also may be purchased from the Commission's copy contractor, International Transcription Service, (202) 857-3800, 2100 M Street, N.W., Suite 140, Washington, D.C. 20037.

We wish to emphasize that the satellite DARS pioneer's preference proceedings to which the Panel's report pertains remain restricted. Parties to these proceedings include Primosphere, DSBC, CD Radio and American Mobile Radio Corporation (AMRC). AMRC does not have a pending satellite DARS pioneer's preference application, but it does have a pending satellite DARS license application. In a Public Notice dated September 30, 1996 (DA 96-1650), the Commission restricted the pioneer's preference proceedings and stated in relevant part:

> ex parte presentations made to or from decision-making personnel in the DARS pioneer's preference proceedings are prohibited until the Commission's final disposition of each is no longer subject to reconsideration or judicial review. Members of the panel organized by the Office of Engineering and Technology and the International Bureau to review the DARS pioneer's preference requests (see below) are to be deemed decision-making personnel for purposes of the ex parte rules. The above-referenced parties (CD Radio, DSBC, Primosphere and AMRC) shall be deemed to be parties to all of the pioneer's preference proceedings for purposes of the ex parte rules.

- FCC -

LIST OF DOCUMENTS FORWARDED TO EXPERT PANEL FOR REVIEW OF DARS PIONEER'S PREFERENCE REQUESTS*

1) Request for Pioneer's Preference filed by Satellite CD Radio ("CD Radio") (9/30/91)

2) January 23, 1992 Supplement to Request for Pioneer's Preference filed by CD Radio (1/23/92)

3) Supplement to Pioneer's Preference Request filed by CD Radio (6/2/93)

4) Supplement to Pioneer's Preference Request filed by CD Radio (9/20/95)

5) Comments filed by CD Radio (1/29/93)

6) Reply Comments of American Mobile Radio Corp. (3/1/93)

7) Pioneer's Preference Request filed by Digital Satellite Broadcasting Corporation ("DSBC")(6/2/93)

8) Application of DSBC for a Digital Audio Radio Satellite System (12/15/92)

9) Amendment of Pioneer's Preference Request filed by DSBC (9/20/95)

10) Petition to Deny Application by DSBC filed by Satellite CD Radio (4/9/93)

11) Opposition to Petition to Deny and Response to Comments filed by DSBC (5/21/93)

12) Reply of DSBC (to comments concerning the NPRM and FNOI) ((3/1/93)

13) Request for Pioneer's Preference of Primosphere Limited Partnership ("Primosphere")(6/2/93)

14) Supplement to Request For Pioneer's Preference of Primosphere)9/20/95)

15) Application of Primosphere (for DARS License) (12/15/92)

16) Petition to Deny Primosphere's Application for DARS License filed by Satellite CD Radio (4/9/93)

17) Reply of Primosphere Limited Partnership to Comments and Petitions to Deny (5/21/93)

18) Experimental Report submitted by CD Radio (4/12/94)

19) Experimental Report submitted by CD Radio (11/23/94)

20) Experimental Report submitted by CD Radio (7/24/94)

21) U.S. Patent assigned to CD Radio Inc. (1/16/96)

22) U.S. Patent assigned to CD Radio Inc. (6/7/94)

23) Ex parte submission of CD Radio (3/22/96)

24) Ex parte submission of CD Radio (3/29/96)

25) Comments of CD Radio (9/15/95) (See especially pages 94-96)

26) Reply Comments of CD Radio (10/13/95) (See especially pages 53-56)

27) Petition to Deny filed by Primosphere (11/13/92)

28) Opposition to Petition to Deny filed by CD Radio (12/1/92)

29) Primosphere's Response to Opposition to Petition to Deny (12/15/92)

30) Submission by Primosphere (10/2/96)(as corrected 10/3/96)

31) Submission by American Mobile Radio Corporation (10/2/96)

32) Submission by Satellite CD Radio (10/2/96)

33) Submission by DSBC (10/2/96)

34) Submission by DSBC (9/13/96)

35) Original Application of CD Radio (7/30/91)

* See also, letters to the Panel from Commisson staff, dated, August 30, September 14, September 20 and October 3, 1996. These letters are part of the record.

November 18, 1996
Washington, D.C.

Mr. John Stern
Federal Communications Commission
International Bureau
2000 M Street, N.W.
Washington, D.C. 20554

Subject: Panel's Evaluation of DARS Pioneer's Preference Requests

Dear Mr. Stern:

The panel formed by the FCC to evaluate primarily technical aspects of three pioneer's preference applications for the DARS service in the U.S. is pleased to present its evaluation. This appears in the accompanying report entitled: "Evaluation of Pioneer's Preference Applications to the FCC that were Submitted by Three DARS Applicants".

The report reflects a consensus among the four panel members. The conclusions stated in the report are agreed upon unanimously.

My colleagues-- John Gilsenan (State Dept.), Jim Hollansworth (NASA), Bill Long (DISA)-- and I hope our assistance will be of value to the FCC in its deliberations on the introduction of the DARS service.

Sincerely,

Don Messer

Don Messer, Dr. Eng.
USIA

November 18, 1996

EVALUATION OF PIONEER'S PREFERENCE APPLICATIONS TO THE FCC THAT WERE SUBMITTED BY THREE DARS APPLICANTS

I. INTRODUCTION

The FCC formed a panel of four members of the U.S. Federal Government to assist it in evaluating three applications for pioneer's preference treatment from three of the four applicants for licenses for Digital Audio Radio Satellite (DARS) domestic services.

As described in an August 30, 1996 letter to each of us, the criteria we were to use were the following two: "... an applicant must demonstrate:

1) 'that it (or its predecessor in interest) has developed the capabilities or possibilities' of a new service or technology 'or has brought them to a more advanced or effective state'...., AND

2) 'the technical feasibility of its proposal, by summarizing its experimental results in its preference application, unless it instead submits an acceptable showing of technical feasibility...'."

Thirty-five documents were submitted to us for review. They consisted of license applications, pioneer's preference applications, DARS NOI comments and reply comments, and several special documents from an applicant reacting to the application of another applicant.

Our report to the FCC on this matter consists of six sections beyond this one:

- Major conclusions,
- Relevant background on the Broadcasting Satellite Service (Sound) {BSS(S)},
- Discussion of the major conclusions,
- Discussion of the CD Radio application,
- Discussion of the DSBC application, and
- Discussion of the Primosphere application.

This is a summary report; if necessary, we could supply more details with respect to our unanimously agreed upon conclusions.

II. MAJOR CONCLUSIONS

Based upon our review of all the documents submitted to us at various times from August 30, 1996 to October 3, 1996 and from our detailed involvement over the years in all aspects of digital sound broadcasting via satellite (and terrestrially), we unanimously conclude that none of the three organizations that applied for a pioneer's preference for DARS service should be awarded such a preference.

Our conclusions are first summarized in general and then specifically for each applicant in Sections IV through VII. Before that, in the next section we summarize the long history of the development of the Broadcasting Satellite Service (Sound) {BSS(Sound)}.

III.RELEVANT BACKGROUND ON THE BROADCASTING SATELLITE SERVICE (SOUND)

This section is divided into three subsections pivoting on 1990, because that is the year that the first DARS service licensing application was received at the FCC.

1. Activities Before Mid-1990

Interest in communications satellites capable of transmitting audio programs to fixed, portable and mobile receivers began in the late 1960's in the form of analytic studies matched to the technology of that era. In the late 1970's and early 1980's, with the advent of possibly applicable digital techniques and more powerful satellite transponders, more serious endeavors began. The primary work, still analytic, was undertaken by European and U.S. organizations, particularly the European Broadcasting Union, the Voice of America (VOA) and the National Aeronautics and Space Administration (NASA).

There were proposals for BSS(Sound) allocations as early as the 1979 WARC. None were made at that time. However, WARC-79 did adopt Resolution 505 in which administrations were encouraged to carry out experiments in the 0.5 to 2.0 GHz band. It also directed the CCIR to expedite studies of technical characteristics and authorized a future competent WARC to take decisions concerning allocation of a suitable frequency band and procedures for protecting terrestrial services using a newly allocated band, or reaccommodating them if necessary.

Two important events occurred in 1988. For the first time the U.S. Government, not just its broadcasting arm, the VOA, saw the need to look favorably upon an eventual frequency allocation for BSS(Sound). (One of us directed a task force for a Committee of

Principals, headed by the National Security Council, to look into the advantages for U.S. public diplomacy purposes to the introduction of satellite radio. The task force's positive conclusion was accepted.) Thus, at WARC-88, the U.S. was among those nations that favored a near future conference to have the topic on its agenda. Second, the European Broadcasting Union at WARC-88 in Geneva conducted an impressive demonstration of a digital transmitter/receiver mobile system that simulated satellite delivery from a mountain top in France near Geneva. It had been developing the system, known as Eureka 147, since 1985.

During 1989 and early 1990 European, Canadian and U.S. efforts in this area were largely devoted to preparing for WARC-92 since the BSS(Sound) issue had been made an allocation agenda item. In Europe, a satellite system, called Archimedes, was proposed. The Eureka 147 system was under constant improvement, on its way to standardization among the European Community, with hopes of making the system a worldwide standard. Also numerous studies were conducted in the U.S., Canada, Australia and Europe on the satellite system aspects of radio delivery via satellite without specifying a particular transmit/receive digital system.

It is clear that significant work was conducted prior to mid-1990 on the development of digital radio via satellite to receivers, including those in moving vehicles.

2. From Mid-1990 through 1991

The Voice of America (VOA) and NASA funded and directed the Jet Propulsion Laboratory (JPL) on a series of analytic studies that eventually provided seminal information to WARC-92 delegates. These agencies, within the Federal Government, were instrumental in developing the U.S. proposal on this frequency allocation agenda item. And the U.S. delegation component at WARC-92 for this topic was headed by one of us.

The VOA and NASA, as part of their efforts to convince U.S. industry and other administrations to favor a frequency allocation for BSS(Sound), demonstrated the first satellite-based delivery of mobile CD quality digital audio. This was done in the Washington, D.C. area during November and December of 1991. The uplink facility was provided by Comsat in Connecticut; an INMARSAT L-band Marecs-B satellite was used. The VOA/JPL system used for the demonstration was a forerunner of a very efficient transmit/receive system developed since then for use at either L-band or S-band.

Canadian and European research and development organizations continued to promote the concept looking toward a frequency allocation for both satellite and terrestrial delivery of digital radio. This detailed analytic work explored the ways that satellite delivery could be augmented by terrestrial signals in urban and

suburban areas (the "gap filler" concept).

In mid-1990 the FCC received its first application for a DARS license from (Satellite) CD Radio, Inc. As noted in some of the documents we reviewed, this organization assisted in the preparation of the U.S. proposal to WARC-92.

3. From 1992 to the Present

Three allocations were made at WARC-92 for BSS(S) and BS(complementary terrestrial). A 50 MHz allocation by footnote for the U.S. in the allocation table at 2310 - 2360 MHz officially became a U.S. domestic allocation for DARS in January 1996.

The VOA/JPL developed their digital transmit/receive system into a robust prototype. This became the center piece for a series of experiments, using NASA Tracking and Data Relay Satellites (TDRS), that has supplied the world with definitive information on the propagation environment that will be faced by DARS service providers. In addition, Europeans and Australians have conducted limited satellite experiments with the Eureka 147 system, with similar but less favorable results.

The terrestrial emulations by CD Radio and its cross polarization experiment with a TDRS satellite were described in some of the documents we reviewed.

4. Summary

Activity leading toward implementing BSS(Sound) has been going on for nearly three decades. Satellite experiments, as best as can be done using existing low powered S-band and L-band satellites, have provided a wealth of propagation information. These experiments have been conducted since 1991. Based on them, there is no longer any difficulty in understanding what the technical requirements are to provide different levels of service to mobile and other receivers.

IV. DISCUSSION OF THE MAJOR CONCLUSIONS

1. From a Listener's Standpoint, Radio Broadcasting Should be "Seamless"

A radio broadcaster defines a coverage area for his broadcasts. Whether this be a small, local coverage area of tens of square miles, or all or most of the U.S., as in DARS proposals, or anything in between, the listeners of the broadcasts expect

"seamless" reception. That is, an uninterrupted, high quality signal is expected everywhere within the coverage area as defined by the coverage contours for the particular service.

Such an availability requirement within the broadcast coverage area is especially important for mobile reception. Listeners in cars and trucks do not want a signal dropping in and out within their driving locality.

Each of the DARS applicants has stressed that its main, if not exclusive, market is the mobile market.

Any proposed system for satellite radio broadcasting needs to provide a local "seamless" broadcast service within an urban or suburban area, or on a highway where typical driving distances take a few hours or less. We considered it essential that a DARS applicant who requests a pioneer's preference must show that through its innovative efforts this "seamless" service will be accomplished for use by listeners in cars in the ways that car radios are used. (This is not the same attribute as the oft-quoted point that DARS will provide the same program across the country wherever the signal is strong enough to do so.)

2. None of the Applicants Demonstrates a "Seamless" Broadcasting DARS Service in a Manner that Would Justify a Pioneer's Preference

A pioneer's preference could be warranted on the basis of the conjunction of two factors: a truly innovative service of guaranteed high quality coupled with a technical design to provide this service that clearly embodies original ideas, and that places an applicant in a privileged position to provide such a service.

We find that none of the three DARS service applicants who have asked for a pioneer's preference can justify that it can provide a locally "seamless" service. They are all deficient in this respect, and additionally there is nothing that justifies a preference on technical design grounds of one system over the other three DARS service applicants.

Section III summarized the considerable work that has been done toward the development of BSS(Sound) and complementary terrestrial broadcasting at the microwave frequencies eventually allocated at WARC-92. Very little of this work was accomplished by the applicants. The vast majority was done by European, Canadian and U.S. Federal Government agencies. Much of this material is in the public domain; all of the U.S. Federal Government work is.

In addition, the same frequency region (1 to 3 GHz) is used by other satellite communication and terrestrial providers, including the mobile satellite service. Significant work on propagation

characteristics, satellite system design, modulation and error correction techniques, etc. has been done over at least two decades for the mobile satellite service. Although the radio broadcasting service has some of its own special characteristics, such as one way communication, overall there is a great deal of combined applicability as far as engineering techniques are concerned between it and the mobile satellite service. For example, a technique such as CDMA did not need to be "invented" for DARS. It already exists and can be applied if a designer decides that this technique fits best in its overall DARS design.

After careful review of the designs presented in the documents, we find that "gap fillers" will be necessary to serve areas "seamlessly" for these designs. Once this is understood, the satellite signal delivery techniques described become no more than different ways of minimizing the local level of dependence on "gap fillers". In particular, the number and power levels required to combat the effects of building and foliage blockage will vary among the designs. Nevertheless, none of the designs overcomes the fundamental coverage problem cited. Satellite space diversity, a 20 meter diameter satellite downlink antenna, CDMA vs. some other program bundling technique, etc. all become ways of only solving part of the piece.

In summary, given the two criteria for pioneer's preference we were asked to focus upon, we find that none of the proposed DARS service designs meets both of these FCC criteria for a pioneer's preference award.

V. DISCUSSION OF THE CD RADIO APPLICATION

CD Radio makes several claims about not only being the first DARS license applicant, but being innovative and crucial to the eventual implementation of a DARS service. In effect, it says that it was there first and has done important experiments.

The former is certainly true. Its application to the FCC in mid-1990 was the first.

However, as shown in Section III, definitions of service requirements, cost and effectiveness trade-off analysis, propagation experiments, and even satellite broadcast emulations and actual satellite broadcast experiments at the appropriate frequency range preceded any work of this sort by CD Radio. CD Radio borrowed some of these data and techniques.

To illustrate the point, CD Radio's first signal delivery technique, developed by Stanford Telecom, involved an elaborate "frequency hopping" technique, that was then abandoned. Over time

CD Radio has continued to modify its ideas, and now favors a well-known CDMA technique.

A key item in much of the CD Radio pioneer's preference documentation is its planned use of satellite space diversity--that is, two satellite platforms separated in this case by 30 degrees in geostationary orbit broadcasting the same program to all points in its coverage area. While there is no doubt that the chance of receiving at least one of two signals coming from different directions will be greater than that of receiving a single signal, there should also be no doubt that in an urban or suburban area two signals will not satisfy a "no blockage" criterion to the extent of obtaining "seamless" coverage.

With elevation angles of 50 degrees or less (typical in the U.S. for geostationary satellites) there will be many situations in urban areas where buildings will block both signals. An example is the south side (or all) of an east/west street with medium to tall buildings on the south side. Any street with a tree canopy (or sporadically covered over or nearly so) will have both signals blocked no matter what its orientation to the equatorial plane. These are not isolated instances. Thus, no matter what probability increment is added to a single satellite system's urban and suburban reception availability by introducing a second satellite with diversity geometry, it still will not eliminate enough of the gaps in coverage within the planned broadcast coverage contour from the satellite(s). All that can be said of this approach is that there will be fewer holes and probably smaller ones on the average.

Based on the technique proposed by CD Radio, if very low powered "gap fillers" are to be employed, it will need fewer of them than for a single satellite system. However, "gap fillers" can be designed, with the appropriate modulation methods, to be higher powered, requiring perhaps just one or a few for an urban/suburban area. For this solution, there is little advantage to employ two geostationary satellites.

Patch antennas for mobile reception, which is another highlighted element in the CD Radio documentation, have been used by others. For example, some of the experimentation done since 1991 by the VOA/JPL has used a patch antenna design.

VI. DISCUSSION OF THE DSBC APPLICATION

DSBC's radio service is different in part from that of the other three DARS license applicants. It proposes "lower 48" (CONUS) coverage, as do the others, for some of its broadcasts. In addition, it plans to serve "regional markets" such as a large fraction of California, with broadcasts utilizing a narrow beam.

Over 30 of these are part of its design. These beams in the aggregate cover most of the U.S. population.

To accomplish this regional market partitioning at S-band will require a 20 meter antenna. This technological choice, plus the market segmentation that would be possible as a result, is at the heart of DSBC's pioneer's preference application.

There is a great deal of controversy over how difficult it will be to launch, deploy and then maintain narrow beam stability of a 20 meter downlink antenna. For example, it doesn't take much of a an angular drift for a southern California beam to end up for a while offshore in the Pacific Ocean.

Even at the increased power flux density levels that the large downlink antenna will provide compared to the more traditional 3 to 5 meter antennas, "gap fillers' will be needed, as noted in DSBC documents.

Taken as a package, we see nothing in the DSBC service proposal that would justify a pioneer's preference. With respect to the antenna size, if it has been done before at S-band, no matter what the cost, then it falls into the category of many of the techniques already developed by others (e.g. CDMA for modulation); or if it is very risky (and innovative), DSBC has not made an acceptable showing of technical feasibility.

Furthermore, DSBC states that it doesn't think any DARS license applicant should receive a pioneer's preference. But, in effect, if awards are made, it wants one.

VII. DISCUSSION OF THE PRIMOSPHERE APPLICATION

Primosphere proposes to operate as a broadcaster, offering a wide range of CD quality musical programming plus up to six talk or non-music channels from two geostationary satellites. It notes the non-subscription, advertising aspect of its marketing strategy as a reason for obtaining a pioneer's preference award. This attribute is not a powerful one in light of the FCC's criteria.

Primosphere presents very little technical information either in its pioneer's preference application or in its license application.

With respect to its request for a pioneer's preference, it seems to be saying that if the FCC wishes to take this route, then Primosphere should receive an award.